CLAIMS

What is claimed is:

1. A method comprising:

transmitting training tones over a plurality of spatial channels during a first portion of an orthogonal frequency division multiplexed packet preamble, the training tones being interspersed among subcarrier frequencies of the spatial channels; and

retransmitting the training tones during a second portion of the packet preamble, the training tones being shifted among the subcarrier frequencies of the spatial channels during retransmission.

2. The method of claim 1 wherein each of a plurality of antennas is associated with one of the spatial channels, the spatial channels having differing multipath characteristics comprising a plurality of orthogonal subcarriers, each subcarrier having a null at substantially a center frequency of the other subcarriers of an associated channel,

wherein the training tones are transmitted on a first set of the orthogonal subcarriers of the spatial channels during the first portion of the packet preamble, and

wherein the training tones are transmitted on a second set of the orthogonal subcarriers during the second portion of the packet preamble, the second set of subcarriers comprising substantially different subcarriers than the first set.

3. The method of claim 1 further comprising prior to retransmitting, shifting the training tones to differing subcarrier frequencies of the spatial channels for retransmission, the differing subcarrier frequencies having not been used for transmission during the first portion of the packet preamble.

4. The method of claim 3 wherein during the second portion of the packet preamble, the training tones are shifted by either one, two or three positions when four antennas are used for transmitting.

5. The method of claim 1 wherein the training tones comprise a single known orthogonal training sequence,

wherein the training sequence is initially transmitted during the first portion of the packet preamble, and

wherein the training sequence is retransmitted during the second portion of the packet preamble.

6. The method of claim 1 wherein the training tones comprise a known training sequence,

wherein the training sequence transmitted during the first portion comprises two or more repeated subsequences, and

wherein the training sequence transmitted during the second portion comprises two or more repeated subsequences.

7. The method of claim 1 further comprising transmitting training tones in subsequent portions of the packet preamble, wherein a number of portions of the packet preamble comprising the training tones corresponds to a number of transmit antennas.

8. The method of claim 5 wherein the transmitting and retransmitting are performed by a high-throughput transmitting station, and wherein a high-throughput receiving station is to receive at least the first and second portions of the packet preamble and is to perform a channel estimation for the spatial channels based on the known training sequence.

9. The method of claim 8 wherein the high-throughput receiving station comprises a plurality of receive antennas, each receive antenna corresponding to one of the spatial channels, and wherein the high-throughput receiving station

combines data bits from each spatial channel to generate a demodulated orthogonal frequency division multiplexed symbol.

10. The method of claim 8 wherein the high-throughput receiving station comprises a single receive antenna to processes the signals from the spatial channels, the high-throughput receiving station to perform signal processing to separate data symbols transmitted on each spatial channel and to combine data bits from each spatial channel to generate a demodulated orthogonal frequency division multiplexed symbol.

11. The method of claim 8 wherein a standard-throughput communication station having a single receive antenna receives at least the first and second portions of the packet preamble, and

wherein the standard-throughput communication station sets a network allocation vector in response to processing of the training tones and refrains from transmitting during a subsequent predetermined time frame.

12. The method of claim 1 further comprising transmitting a data unit portion of the orthogonal frequency division multiplexed packet following the first and second portions of the preamble, and

wherein for high-throughput operation, the data unit portion comprises data symbols transmitted on the subcarriers of each spatial channel to achieve a higher throughput, each spatial channel having separate data streams transmitted thereon.

13. The method of claim 12 wherein for lower packet error rate operations, the data unit portion comprises identical data symbols transmitted on corresponding subcarriers of each spatial channel, each spatial channel having substantially identical data streams transmitted thereon, and

wherein for medium throughput and medium packet error rate operations, the data unit portion comprises identical data symbols transmitted on corresponding subcarriers of at least some of the spatial channels and comprises different data symbols transmitted on at least some others of the spatial channels.

14. The method of claim 12 wherein for lower packet error rate operations, the data unit portion comprises linear combinations of spatial streams transmitted on corresponding subcarriers of each spatial channel, and

wherein for medium throughput and medium packet error rate operations, the data unit portion comprises linear combinations of spatial streams transmitted on corresponding subcarriers of at least some of the spatial channels and comprises different data symbols transmitted on at least some others of the spatial channels.

15. A method comprising:

receiving training tones transmitted over a plurality of spatial channels during a first portion of an orthogonal frequency division multiplexed packet preamble, the training tones being interspersed among subcarrier frequencies of the spatial channels;

receiving the training tones retransmitted over the spatial channels during a second portion of the packet preamble, the training tones being interspersed among other subcarrier frequencies of the spatial channels during the second portion; and

performing a channel estimation for the spatial channels based on the training tones received in both portions of the packet preamble.

16. The method of claim 15 wherein the channel estimation is performed for the subcarriers of each spatial channel based on the training tones received on associated subcarriers of the spatial channels,

wherein the method further comprises performing an interpolation to determine channel estimates for subcarriers not having a training tone transmitted thereon during either portion of the packet preamble, and

wherein the training tones comprise a known training sequence.

17. The method of claim 16 wherein performing the interpolation comprises performing an interpolation to determine channel coefficients at zero tones on each of a plurality of transmit antennas.

18. The method of claim 17 wherein a high-throughput communication station receives the training tones and performs the channel estimation, and wherein the method further comprises:

demodulating an orthogonal frequency division multiplexed data symbol transmitted over the spatial channels by separately processing signals received through each of the spatial channels.

19. The method of claim 16 wherein the reception of the training tones is performed by a standard-throughput communication station having a single receive antenna and wherein the method further comprises:

the standard-throughput communication station setting a network allocation vector in response to processing the training tones; and

the standard-throughput communication station refraining from transmitting during a subsequent predetermined time frame based on the network allocation vector.

20. The method of claim 14 wherein the high-throughput communication station is a high-throughput receiving communication station having a receive antenna associated with each of the spatial channels, and

the method further comprises performing an association with a high-throughput transmitting station to inform the transmitting station that the receiving station has a plurality of antennas to receive over a corresponding plurality of spatial channels.

21. A high-throughput communication station comprising:

a transmitter to transmit training tones over a plurality of spatial channels during a first portion of an orthogonal frequency division multiplexed packet preamble, the training tones being interspersed among subcarrier frequencies of the spatial channels, the transmitter to retransmit the training tones during a second portion of the packet preamble, the training tones being shifted among the subcarrier frequencies of the spatial channels during retransmission; and

a processor to shift the training tones to differing subcarrier frequencies of the spatial channels for the retransmission, the differing subcarrier frequencies

comprising subcarrier frequencies not used for transmission during the first portion of the packet preamble.

22. The communication station of claim 21 further comprising a plurality of antennas,

wherein each antenna is associated with one of the spatial channels,

wherein the spatial channels have differing multipath characteristics of a single orthogonal frequency division multiplexed channel comprising a plurality of orthogonal subcarriers, and

wherein each subcarrier has a null at substantially a center frequency of the other subcarriers of the orthogonal frequency division multiplexed channel.

23. The communication station of claim 21 wherein the training tones comprise a single known orthogonal training sequence,

wherein the transmitter is to initially transmit the training sequence during the first portion of the packet preamble, and

wherein the transmitter is to retransmit the training sequence during the second portion of the packet preamble.

24. The communication station of claim 21 wherein the transmitter is to transmit a data unit portion of the orthogonal frequency division multiplexed packet following the first and second portions of the preamble,

wherein for high-throughput operation, the data unit portion comprises data symbols transmitted on the subcarriers of each spatial channel to achieve a higher throughput, each spatial channel having separate data streams transmitted thereon,

wherein for lower packet error rate operations, the data unit portion comprises identical data symbols transmitted on corresponding subcarriers of each spatial channel, each spatial channel having substantially identical data streams transmitted thereon, and

wherein for medium throughput and medium packet error rate operations, the data unit portion comprises identical data symbols transmitted on

corresponding subcarriers of at least some of the spatial channels and comprises different data symbols transmitted on at least some other of the spatial channels.

25. A high-throughput communication station comprising:

a receiver to receive training tones transmitted over a plurality of spatial channels during a first portion of an orthogonal frequency division multiplexed packet preamble, the training tones being interspersed among subcarrier frequencies of the spatial channels, the receiver to receive the training tones retransmitted over the spatial channels during a second portion of the packet preamble, the training tones being interspersed among other subcarrier frequencies of the spatial channels during the second portion; and

a processor to perform a channel estimation for the spatial channels based on the training tones received in both portions of the packet preamble.

26. The communication station of claim 25 further comprising a plurality of receive antennas,

wherein each receive antenna is associated with one of a plurality of spatial channels,

wherein the spatial channels have differing multipath characteristics of a single orthogonal frequency division multiplexed channel comprising a plurality of orthogonal subcarriers,

wherein each subcarrier has a null at substantially a center frequency of the other subcarriers of the orthogonal frequency division multiplexed channel, and

wherein the processor is to combine data bits from the spatial channels to generate a demodulated orthogonal frequency division multiplexed symbol.

27. The communication station of claim 26 wherein the training tones comprise a single known orthogonal training sequence,

wherein the receiver is to initially receive the training sequence during the first portion of the packet preamble, and

wherein the receiver is to receive the training sequence for a second time during the second portion of the packet preamble.

28. The communication station of claim 25 further comprising a single receive antenna to processes signals received from the spatial channels, and

wherein the processor is to perform signal processing to separate data symbols transmitted on each spatial channel and to combine data bits from each spatial channel to generate a demodulated orthogonal frequency division multiplexed symbol.

29. A system comprising:

a plurality of substantially omnidirectional antennas, each associated with one of a plurality of spatial channels;

a transmitter to transmit training tones over the spatial channels during a first portion of an orthogonal frequency division multiplexed packet preamble, the training tones being interspersed among subcarrier frequencies of the spatial channels, the transmitter to retransmit the training tones during a second portion of the packet preamble, the training tones being shifted among the subcarrier frequencies of the spatial channels during retransmission; and

a processor to shift the training tones to differing subcarrier frequencies of the spatial channels for the retransmission, the differing subcarrier frequencies comprising subcarrier frequencies not used for transmission during the first portion of the packet preamble.

30. The system of claim 29 wherein the spatial channels have differing multipath characteristics of a single orthogonal frequency division multiplexed channel comprising a plurality of orthogonal subcarriers, each subcarrier having a null at substantially a center frequency of the other subcarriers of the orthogonal frequency division multiplexed channel,

wherein the training tones comprise a single known orthogonal training sequence,

wherein the transmitter is to initially transmit the training sequence during the first portion of the packet preamble, and

wherein the transmitter is to retransmit the training sequence during the second portion of the packet preamble.

31. The system of claim 30 wherein the transmitter is to transmit a data unit portion of the orthogonal frequency division multiplexed packet following the first and second portions of the preamble,

wherein for high-throughput operation, the data unit portion comprises data symbols transmitted on the subcarriers of each spatial channel to achieve a higher throughput, each spatial channel having separate data streams transmitted thereon,

wherein for lower packet error rate operations, the data unit portion comprises identical data symbols transmitted on corresponding subcarriers of each spatial channel, each spatial channel having substantially identical data streams transmitted thereon, and

wherein for medium throughput and medium packet error rate operations, the data unit portion comprises identical data symbols transmitted on corresponding subcarriers of at least some of the spatial channels and comprises different data symbols transmitted on at least some others of the spatial channels.

32. The system of claim 30 wherein the transmitter is to transmit a data unit portion of the orthogonal frequency division multiplexed packet following the first and second portions of the preamble,

wherein for high-throughput operation, the data unit portion comprises data symbols transmitted on the subcarriers of each spatial channel to achieve a higher throughput, each spatial channel having separate data streams transmitted thereon,

wherein for lower packet error rate operations, the data unit portion comprises linear combinations of spatial streams transmitted on corresponding subcarriers of each spatial channel, and

wherein for medium throughput and medium packet error rate operations, the data unit portion comprises linear combinations of spatial streams transmitted on corresponding subcarriers of at least some of the spatial channels and comprises different data symbols transmitted on at least some others of the spatial channels.

33. A machine-readable medium that provides instructions, which when executed by one or more processors, cause the processors to perform operations comprising:

transmitting training tones over a plurality of spatial channels during a first portion of an orthogonal frequency division multiplexed packet preamble, the training tones being interspersed among subcarrier frequencies of the spatial channels; and

retransmitting the training tones during a second portion of the packet preamble, the training tones being shifted among the subcarrier frequencies of the spatial channels during retransmission.

34. The machine-readable medium of claim 33 wherein the instructions, when further executed by one or more of the processors cause the processors to perform operations, comprising performing a channel estimation for each of the spatial channels based on a known training sequence comprising the training tones.

35. The machine-readable medium of claim 33 wherein the instructions, when further executed by one or more of the processors cause the processors to perform operations further comprising transmitting a data unit portion of the orthogonal frequency division multiplexed packet following the first and second portions of the preamble,

wherein for high-throughput operation, the data unit portion comprises data symbols transmitted on the subcarriers of each spatial channel to achieve a higher throughput, each spatial channel having separate data streams transmitted thereon,

wherein for lower packet error rate operations, the data unit portion comprises identical data symbols transmitted on corresponding subcarriers of each spatial channel, each spatial channel having substantially identical data streams transmitted thereon, and

wherein for medium throughput and medium packet error rate operations, the data unit portion comprises identical data symbols transmitted on

corresponding subcarriers of at least some of the spatial channels and comprises different data symbols transmitted on at least some others of the spatial channels.